CLAIMS

What is claimed is:

1. A method for welding single crystal superalloys comprising the steps of: using a high power energy source to both preheat and melt a filler comprising a superalloy and to cause melting of at least a portion of a surface of a substrate comprising a single crystal superalloy; and depositing said filler onto the portion of the surface of the substrate to form a solid clad on the substrate to provide a superalloy weld.

2. The method for welding single crystal superalloys of Claim 1 wherein said high power energy source is a laser.

3. A method for welding single crystal superalloys comprising the steps of: providing a substrate to be treated, said substrate comprising a single crystal superalloy;

providing a filler, said filler comprising a superalloy; exposing said filler to a high power energy source to cause preheating and melting of said filler by said high power energy source;

exposing a portion of a surface of said substrate to said high power energy source to cause partial melting of the portion of the surface of said substrate by said high power energy source; and

depositing said filler onto the portion of the melted surface of said substrate to form a solid clad on said substrate to provide a superalloy weld.

4. The method for welding single crystal superalloys according to Claim 3 further comprising the step of: providing said substrate is selected from at least one of the group consisting of SC 180, RENÉ N5 and N6, CMSX-2, CMSX-4 and CMSX-10, and PWA 1480 and 1484.

5. The method for welding single crystal superalloys according to Claim 3 further comprising the step of: providing said substrate comprises elements selected from at least one of the group consisting of Ni, Co, Cr, Mo, W, Ta, Al, Ti, Re, Nb, Hf, C and B.

6. The method for welding single crystal superalloys according to Claim 3 further comprising the step of: providing said filler is selected from at least one of the group consisting of HS-188, HASTELLOY X, INCO 713, INCO 738, INCO 939, MAR-M247, RENÉ 80, C 101 and modified MCrAlY.

7. The method for welding single crystal superalloys according to Claim 6 wherein said modified MCrAlY is modified with an element selected from at least one of the group consisting of Pt, Pd, Re, Ta, Hf, Zr, Si, C and B.

8. The method for welding single crystal superalloys according to Claim 6 wherein said M of said MCrAlY is selected from at least one of the group consisting of Ni, Co and Fe or combination thereof.

9. The method for welding single crystal superalloys according to Claim 3 further comprising the step of: providing said filler comprises an element selected from at least one of the group consisting of Ni, Co, Fe, Cr, W, Mo, Al, Si, Nb, Ti, Ta, Zr, Re, Hf, C, B, Y and La.

10. The method for welding single crystal superalloys according to Claim 3 further comprising the steps of: feeding said filler through a co-axial nozzle of said high power energy source;
shrouding said filler and the portion of the surface of said substrate with an inert gas; and
causing rapid relative motion of a beam of said high power energy source to an adjacent portion of the surface of said substrate allowing a solid clad to form.

11. The method for welding single crystal superalloys according to Claim 10 further comprising the step of: providing said filler in the form of a powder; and
providing a powder feeder for feeding said powder of said filler into said co-axial nozzle.

12. The method for welding single crystal superalloys according to Claim 11 wherein said powder is fed by powder feeder at a rate of about 1.5 to about 20 grams per minute.

13. The method for welding single crystal superalloys according to Claim 11 wherein said powder is fed by said powder feeder at a rate of about 1.5 to about 10 grams per minute.

14. The method for welding single crystal superalloys according to Claim 3 wherein said filler comprises a wire.

15. The method for welding single crystal superalloys according to Claim 10 wherein said rapid relative motion of said beam of said high energy power source is caused at a speed of about 5 to about 22 inches per minute relative to the adjacent portion of the surface of said melted substrate.

16. The method for welding single crystal superalloys according to Claim 10 wherein said rapid relative motion of said beam of said high energy power source is caused at a speed of about 5 to about 14 inches per minute relative to the adjacent portion of the surface of said partially melted substrate.

17. The method for welding single crystal superalloys according to Claim 3 wherein

said high energy power source comprises a laser.

18. The method for welding single crystal superalloys according to Claim 17 wherein said laser is selected from at least one of the group consisting of carbon dioxide, Nd:YAG, diode and fiber lasers.

19. The method for welding single crystal superalloys according to Claim 17 wherein said laser has a power of about 50 to about 2500 watts.

20. The method for welding single crystal superalloys according to Claim 17 wherein said laser has a power of about 50 to about 1500 watts.

21. The method for welding single crystal superalloys according to Claim 17 wherein a laser beam of said laser is defocused by about 0.02 to about 0.1 inches.

22. The method for welding single crystal superalloys according to Claim 17 wherein a laser beam of said laser is defocused by about 0.04 to about 0.06 inches inches.

23. The method for welding single crystal superalloys according to Claim 17 wherein said laser produces a laser-welded clad bead having a width of about 0.02 to about 0.1 inches.

24. The method for welding single crystal superalloys according to Claim 17 wherein said laser produces a laser-welded clad bead having a preferable width of about 0.04 to about 0.06 inches.

25. A welded single crystal superalloy prepared according to the method of Claim 3.

26. A method for repairing a portion of a surface of a single crystal superalloy substrate comprising the steps of:
providing a single crystal superalloy substrate having a surface defect;
providing a superalloy filler;
exposing said filler to a laser source to cause preheating and melting of said filler by said laser source; exposing a portion of a defective surface of said substrate to said laser source to cause melting of the portion of the defective surface of said substrate by said laser source; and
depositing said filler onto the portion of the defective surface of said substrate to form a solid clad on the portion of the defective surface of said substrate to provide a superalloy repair of said surface defect of said substrate.

27. The method for repairing the surface of a single crystal superalloy substrate according to Claim 26 further comprising the steps of:
feeding said filler through a co-axial nozzle of said laser source; shrouding said filler and the portion of the defective surface of said substrate with an inert gas;

and causing rapid relative motion of a beam of said laser source to an adjacent portion of the surface of said substrate allowing a solid clad to form.

28. The method for repairing the surface of a single crystal superalloy substrate according to Claim 27 further comprising the steps of:
providing said filler in the form of a powder; and providing a power feeder for feeding said powder of said filler into said co-axial nozzle.

29. A method for coating the surface of a single crystal superalloy substrate comprising the steps of:
selecting a portion of a surface of a single crystal superalloy substrate to be treated;
providing an advanced superalloy filler;
exposing said filler to a laser source to cause preheating and melting of said filler by said laser source; exposing the portion of the surface of said substrate to said laser source to cause melting of the portion of the surface of said substrate by said laser source; and depositing said filler to form a solid clad onto the portion of the surface of said substrate to provide a single crystal superalloy coating on the surface of said substrate.

30. The method for coating the surface of a single crystal superalloy substrate according to Claim 29 further comprising the steps of:

feeding said filler through a co-axial nozzle of said laser source;

shrouding said filler and the portion of the surface of said substrate with an inert gas; and

causing rapid relative motion of a beam of said laser source to an adjacent portion of the surface of said substrate allowing a solid clad to form.

31. The method for coating the surface of a single crystal superalloy substrate according to Claim 30 further comprising the step of:

providing said filler in the form of a powder; and providing a power feeder for feeding said powder of said filler into said co-axial nozzle.

32. A method for laser-welding a single crystal superalloy substrate comprising the steps of:

providing a substrate comprising a single crystal superalloy selected from at least one of the group consisting of SC 180, RENÉ N5 and N6, CMSX-2, CMSX-4 and CMSX-10, and PWA 1480 and 1484;

providing said substrate comprises at least an element selected from the group consisting of Ni, Co, Cr, Mo, W, Ta, Al, Ti, Re, Nb, Hf, C and B;

providing a filler, said filler selected from at least one of the group consisting of a powder and a wire, said filler comprising a superalloy selected from at least one of the group consisting of HS-188, HASTELLOY X, INCO 713, INCO 738, INCO 939, MAR-M247, RENÉ 80, C 101 and modified MCrAlY;

said MCrAlY modified with at least an element selected from at least one of the group consisting of Pt, Pd, Re, Ta, Hf, Zr, Si, C and B;

said M selected from at least one of the group consisting of Ni, Co and Fe or combination thereof;

exposing said filler to a laser source to cause preheating and melting of said filler by said laser source, said laser source selected from at least one of the group consisting of carbon dioxide, Nd:YAG, diode and fiber lasers; providing said filler comprises elements selected from at least one of the group consisting of Ni, Co, Fe, Cr, W, Mo, Al, Si, Nb, Ti, Ta, Zr, Re, Hf, C, B, Y and La; said laser source having a power of about 50-1500 watts, said laser source including a laser beam defocused by about 0.04 to about 0.06 inches;

exposing a portion of a surface of said substrate to the laser source to cause melting of the portion of the surface of said substrate;

depositing said preheated and melted filler onto the portion of the melted surface of said substrate to form a laser-welded clad bead with epitaxial structure having a width of about 0.04 to about 0.06 inches on the portion of the surface of said substrate;

said preheating and melting of said filler by said laser source being achieved by feeding said filler through a co-axial nozzle of said laser source;

providing a powder feeder, said powder fed into said co-axial nozzle by said by said powder feeder at a rate of 1.5-10 grams per minute; shrouding said preheated and melted filler and the portion of the surface of said melted substrate with an

inert gas selected from at least one of the group consisting of He and Ar; and causing rapid relative motion of a beam of said laser source at a speed of about 5-14 inches per minute to an adjacent portion of the surface of said melted substrate to provide an epitaxial laser-weld.

33. A laser-welded single crystal superalloy prepared according to the method of Claim 32.